1350.0 - Australian Economic Indicators, Jul 1999

ARCHIVED ISSUE Released at 11:30 AM (CANBERRA TIME) 30/06/1999

Special Article - The New Method for Seasonally Adjusting Crop Production Data

This article is reproduced from Australian Economic Indicators, July 1999

INTRODUCTION

Farm crop production data has long been a source of difficulties in terms of seasonal adjustment. The problem is that most types of crops are only harvested in one or two quarters of a year. This leads to a recurring pattern of zeros in the original data preventing the usual Australian Bureau of Statistics (ABS) seasonal adjustment process from being applied. Previously, the solution to this problem was to apply a ‘special adjustment’ that distributes the annual estimates evenly across each of the four quarters. However, this approach is not ideal because it tends to remove irregularity from the series which should remain in a seasonally adjusted series, and allows non-zero movements only between financial years rather than on a quarterly basis. That is, the previous approach does not recognise variations in crop production within the financial year.

This article reports on the new method for seasonally adjusting farm crops implemented from the September quarter 1998 release of the Australian National Accounts (ANA). The article outlines the characteristics of time series data as well as a brief discussion of some of the seasonal adjustment options. In particular, it discusses the previous ‘special adjustment’ in relation to the more favourable characteristics of the new method of seasonally adjusting farm crops.

THE NATURE OF TIME SERIES DATA

Time series data is a statistical record of any social or economic activity which is measured at regular intervals of time. Each observation in a time series is considered to be the net result of three distinct influences, where each interacts with the others and has its own distinguishing character:

- systematic calendar related effects, which include the seasonal pattern and other systematic influences that are calendar based;
- trend, which indicates the underlying direction of the series; and
- residual component, which accounts for the remainder of the series’ short term behaviour and when observed appears irregular.

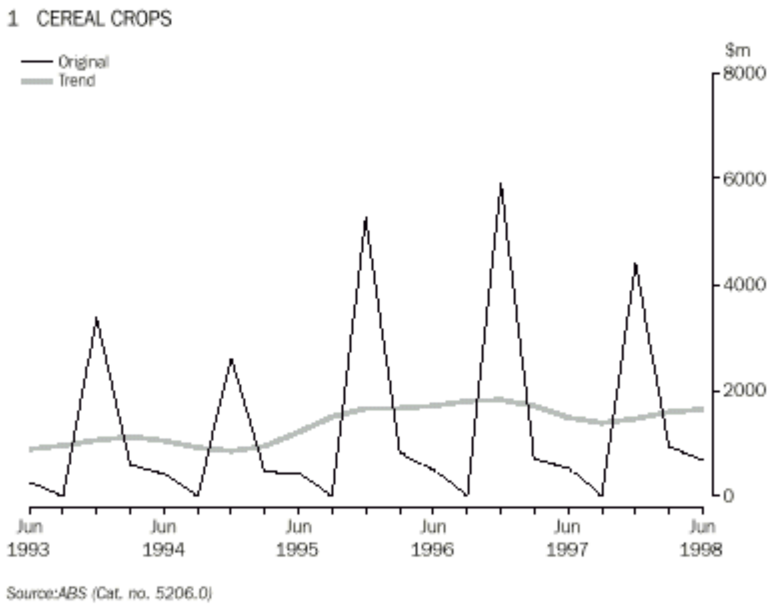
The term ‘original’ is used to describe data containing the full effect of all three influences. Seasonally adjusted estimates are produced by removing the estimated systematic calendar related effects evident in the original data. Trend estimates are produced by removing the

residual component from the seasonally adjusted estimates. References to detailed information on time series are contained in endnote 1.

THE SEASONAL ADJUSTMENT PROCESS

Seasonal adjustment is the statistical process used to estimate and eliminate the systematic calendar related effects from the original data. It is first necessary to identify how the systematic calendar related effects, trend and residual component are related. Analysis shows that for almost all ABS time series data these components appear to be multiplicatively related. This means that the magnitude of the seasonal fluctuations rises and falls in proportion to the level of the trend. A similar relationship to the trend occurs for the residual component, with the magnitude of this component also affected by whether the period in which it occurs is a high or low seasonal period.

Graph 1 illustrates the multiplicative relationship between the seasonal fluctuations and the trend. In the example, the seasonal peak in December varies in magnitude, with the larger peaks corresponding to increases in the level of the trend of the series.



In rare cases a different relationship between the systematic calendar related effects, trend and residual component exists, when the magnitude of the seasonal fluctuations each quarter is not influenced by rises and falls in the level of the trend. Similarly, the residual component is unaffected by trend levels. When this occurs, the components are considered to be additively related.

When the usual multiplicative relationship between the three components of a time series exists, seasonally adjusted estimates are produced by dividing the original data by the estimated seasonal adjustment factors to remove the systematic calendar related effects. However, if the original time series contains a zero observation in one or more periods, at least one of the components must be zero in the same period, and the seasonal adjustment process will lead to a zero divide problem.

If the original time series is characterised by an additive relationship between the three

components, the zero divide problem can be overcome. In this case the seasonally adjusted series is formed by subtracting, rather than dividing, the estimated seasonal factor from the original data. However, this solution is inappropriate if the relationship between the components appears to be multiplicative.

THE ANA REQUIREMENT FOR CROP PRODUCTION DATA

In the compilation of the ANA, five crop groups are identified: wheat, barley, other cereals, sugar, and other non-cereal crops. Generally, these crops have a one year production cycle with no harvesting activity recorded in at least one quarter. For the crop groupings used in compiling the ANA, zero values appear in the quarterly time series data as follows:

- wheat, June and September quarters;
- barley, June and September quarters;
- other cereals, September quarter; and
- sugar, March and June quarters.

The other non-cereal crops group comprises a diverse range of crops (endnote 2) with different production cycles such that no quarter in the time series records a zero value.

THE PREVIOUS "SPECIAL" ADJUSTMENT OF CROP PRODUCTION

Previously a ‘special adjustment’ was applied to all crop production series as a solution to the zero divide problem. The method, otherwise known as ‘annual divide by four’ or ‘annual spreading’, apportioned the total financial year crop production equally over the four quarters of that year.

The result was an extremely smooth ‘adjusted’ time series with the possibility of non-zero movements only at the beginning of each financial year. However, this implied that changes in production only occurred between the June and September quarters. Therefore, for example, drought affected harvests and bumper crops could only be recognised in the initial movement for the financial year. This approach is not a true seasonal adjustment since it does not estimate and remove the seasonal pattern. The ‘special adjustment’ tends to remove part of both the seasonal pattern and the residual component. By definition, the residual component should remain entirely within the seasonally adjusted series. For these reasons, the previous ‘special adjustment’ of crop production was considered unsatisfactory.

THE NEW METHOD OF SEASONALLY ADJUSTING CROP PRODUCTION

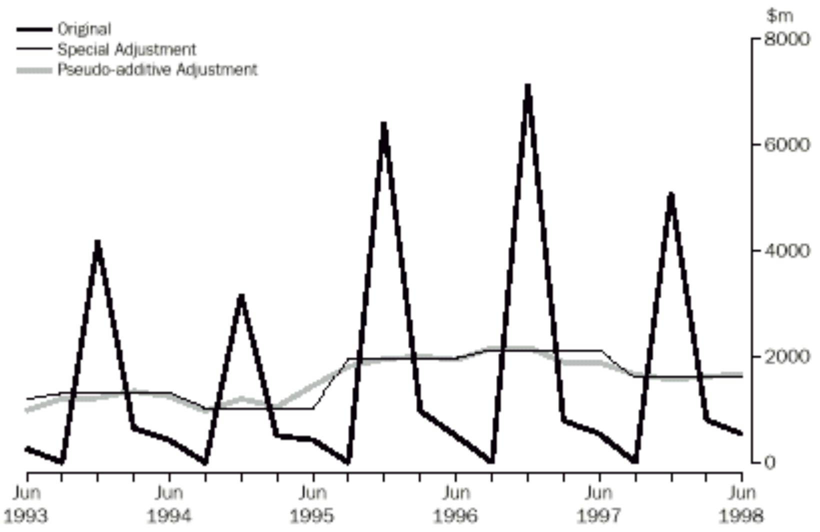
The new method is a hybrid of the multiplicative and additive relationships and is termed the pseudo-additive method. The pseudo-additive method assumes the magnitude of the seasonal fluctuations is influenced by movements in the trend, as is the magnitude of fluctuations in the residual component. However, unlike the multiplicative relationship, the magnitude of the residual fluctuations is not influenced by whether they occur in a high or low seasonal period. Therefore, it is possible to express the three components with an additive relationship between the non-trend components, but with each non-trend component multiplicatively related to the trend. The appendix describes this pseudo-additive method in algebraic terms.

Replacing the multiplicative relationship between the systematic calendar related effects and the residual component with an additive relationship is particularly useful if the series contains one or more zero values. This is because the zero divide problem is avoided by the use of subtraction in the seasonal adjustment process. In this way the method can accommodate one-off zero values as well as regular zero values occurring as a result of a consistent seasonal pattern, as occurs in some crop production time series.

THE APPLICATION OF THE PSEUDO-ADDITIVE METHOD TO CEREAL CROPS

A first step in the application of the new method involves splitting crop output into two categories: cereals (wheat, barley and other cereals) and non-cereals (sugar and other crops). Each category is then seasonally adjusted. The cereal crops category contains one zero value each year in the September quarter and so is seasonally adjusted using the pseudo-additive method, while the output of the non-cereal crops category (which has no zero values) is seasonally adjusted using the multiplicative method. Graph 2 illustrates the original cereal crop data and compares the seasonally adjusted series calculated using the two methods.

2 CEREAL CROPS, Comparison of "Special Adjustment" and Pseudo-additive Adjustment



Source:ABS (Cat. no. 5206.0) and unpublished data

When the pseudo-additive method is applied to cereal crops it results in an improved seasonal adjustment compared to the other methods examined. The pseudo-additive seasonal adjustment factors are more stable than those resulting from the other methods investigated and the September quarter seasonal factors are zero, accurately reflecting the observed seasonal pattern. Therefore, the cereal crops data are adequately described by a pseudo-additive relationship. The pseudo-additive seasonally adjusted series is (appropriately) more volatile than that arising from the 'special adjustment'. This is because unlike the 'special adjustment', the pseudo-additive method only removes the estimated systematic calendar related effects from the original series. The seasonally adjusted series is then able to reflect residual influences as it should, with the effects of bumper harvests or droughts displayed in the quarter in which they occur, rather than the effect being dampened and apparent only in the September quarter movement.

CONCLUSION

The farm crops series in the ANA cannot be adjusted in the same manner as many other ABS series due to consistent zero values in the original data. Previously, a ‘special adjustment’ method was introduced to cope with these zero values. However, the previous method failed to allow variations in the level of the adjusted series other than in the movement from one financial year to the next. The pseudo-additive method retains a multiplicative relationship between the systematic calendar related effects and the trend, and between the residual component and the trend, but assumes the fluctuations caused by the residual component are not affected by whether they occur in a high or low seasonal period. This makes it ideally suited to adjusting a series with zero values occurring as the result of a consistent seasonal pattern since the seasonal adjustment factors can be subtracted from the original series, avoiding the zero divide problem. The pseudo-additive method has been found to describe the cereal crops data adequately. The factors used to derive the seasonally adjusted series using this method must be recalculated each quarter. This allows the seasonally adjusted series to respond to the full impact of irregular influences as they occur during the production year. Compared with the previous method, the new method reflects more accurately the non-seasonal behaviour of farm crops and therefore gives users a better guide to current movements in the farm sector of the Australian economy. The pseudo-additive method has also been used in the ANA to adjust wheat marketing costs and Australian wheat board receivals. It is possible further investigation of the pseudo-additive method will result in it having a much wider application.

ENDNOTES

1. Information Paper: A Guide to Interpreting Time Series—Monitoring ‘Trends’, 1993 (Cat. no. 1349.0)

Information Paper: A Guide to Smoothing Time Series—Estimates of ‘Trend’, 1987 (Cat. no. 1316.0)

Information Paper: Time Series Decomposition—an Overview, 1987 (Cat. no. 1317.0)

2. The other non-cereal crops group is composed of: vegetables, fruit (excluding grapes), cotton, grapes, plant nurseries, pastures and grains, legumes, oilseeds, vegetable seeds, hay, tobacco, peanuts, hops and other.

3.Generally, the seasonal adjustment method used by the ABS is based on the US Bureau of the Census Method II, X11 Variant Seasonal Adjustment Programme, 1967.

APPENDIX

Time series decomposition is the process of partitioning the original data into three distinct components, namely trend, systematic calendar related effects and residual component. Different relationships between these three components may exist, depending on the nature of the particular time series that is being analysed. This appendix examines three different relationships that may apply: multiplicative, additive, and pseudo-additive. In this appendix, the simplest form of these three relationships will be discussed, namely where the only systematic calendar related effect is the seasonal pattern.

MULTIPLICATIVE

A multiplicative relationship between the components of a time series implies that the magnitude of fluctuations in the original series, resulting from the seasonal pattern and the residual

component, is proportional to the level of the trend. That is to say, given that relationship, any observation in original time series data (O) is the result of a multiplicative combination of the trend (T), seasonal pattern (S) and the residual component (R). Algebraically, this can be expressed as:

$$O = T \times S \times R \quad (1)$$

Both the multiplicative seasonal and residual factors are centred around one. The degree to which these factors differ from one provides an indication of the magnitude of the fluctuations due to these influences. For example, a seasonal factor of 1.1 would imply that the seasonal peak in that quarter is approximately 10% above the trend.

An alternative expression for the multiplicative relationship is:

$$O = T + T \times (S - 1) + T \times (R - 1) + T \times (S - 1)(R - 1). \quad (2)$$

In this case the original data is the sum of the contributions of each of the components. The magnitude of the seasonal fluctuations is approximately $T \times (S - 1)$ and the magnitude of the residual fluctuations is approximately $T \times (R - 1)$. These two quantities must be considered approximations since the magnitude of the seasonal fluctuations is also related to the residual component and vice versa, leading to the cross term $T \times (S - 1)(R - 1)$.

If a multiplicative relationship is assumed, the seasonally adjusted series (A) can be derived by dividing the seasonal component into the original series.

$$A = O / S = T \times R \quad (3)$$

ADDITIVE

In contrast to a multiplicative relationship, an additive relationship between the components of a time series implies that the magnitude of fluctuations in the original series resulting from the seasonal pattern and the residual component is unaffected by the level of the trend. Algebraically, this can be expressed as:

$$O = T + S + R \quad (4)$$

If an additive relationship is assumed, the seasonally adjusted series can be derived by subtracting the seasonal component from the original series.

$$A = O – S = T + R \quad (5)$$

PSEUDO-ADDITIVE

In contrast to both the multiplicative and additive relationships, the pseudo-additive relationship implies the magnitude of fluctuations resulting from the seasonal pattern and the residual component are proportional to the level of the trend (T), but the magnitude of the residual fluctuations is not affected by whether the fluctuations occur in high or low seasonal periods.

Pseudo-additive seasonal and residual factors are centred around one, as occurs in the multiplicative relationship and therefore the magnitude of the pseudo-additive seasonal and residual fluctuations can also be described by the quantities $T \times (S – 1)$ and $T \times (R – 1)$ respectively. In the pseudo-additive relationship however, these quantities are exact since the pseudo-additive relationship assumes the seasonal pattern and residual component are not

linked removing the need for the cross term in the multiplicative expression (see equation 2). An algebraic expression for the pseudo-additive relationship is then the sum of the contributions of each of the components:

$O = T + T \times (S - 1) + T \times (R - 1)$. (6)

which simplifies to the standard expression of the relationship:

$O = T \times (S + R - 1)$. (7)

The pseudo-additive seasonally adjusted series can be derived from equation (7) by subtracting the pseudo-additive seasonal component from the original series in much the same way as occurs with the additive relationship. This results in a seasonally adjusted series of the form:

$A = O - T \times (S - 1) = T \times R$. (8)

The additive relationship between the seasonal pattern and residual component in the pseudo-additive relationship makes it possible to cope with zeros. In terms of crops, the September quarter seasonal factor is equal to zero ie $S=0$. That is, the magnitude of the September quarter seasonal fluctuations is equivalent to –100% of the trend. This makes intuitive sense since it is apparent that the zeros in the original data are the result of the seasonal pattern and that the seasonal pattern must therefore negate the positive contribution of the trend in the zero quarters. Furthermore, each September quarter has no fluctuations resulting from the residual component ie $R = 1$. That is, there is no residual component in zero quarters. This also makes intuitive sense, since each zero quarter is exactly zero. Therefore, when the pseudo-additive seasonal pattern is removed, the seasonally adjusted series becomes T in the September quarters and $T \times R$ in the other quarters, and the usual Henderson trending procedure is still applied.

This page last updated 8 December 2006